Automated Result Verification (Autoverification) Of Quantitative Urine Analysis Results: An Improvement In Time And Cost Savings

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Introduction

The Singapore General Hospital's clinical biochemistry lab generates more than **13 million** analytical results a year. A typical lab investigation goes through the following procedure:



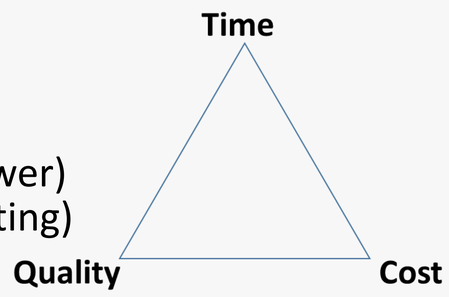
Pre-processing → Analysis → Result **Review** and Reporting
(e.g. blood collection) (Complex instruments) (Through lab info system LIS)

The Quality Triangle and resource limitation

The lab maintains stringent quality procedures to ensure quality lab testing.

However, with limited resources (based on Quality Triangle):
- Quality + Shorter Time = **$$$** (manpower)
- Quality + Lower Cost = **Slow** (slow testing)

Worsen with ↑↑↑workload



Solution? AUTOMATE!

Result review is time consuming and requires manpower. However, with clear defined settings, result review process can be automated (autoverify). The lab decided to autoverify:
- 14 different measured urine analytes
- 13 results calculated from the 14 measured analytes.

The lab aimed to reduce the time taken to manually review results for the 27 analytes by **75%** through autoverification.

Methodology

Data Review Period

The lab surveyed 3 months of data from July to Sept 2020 after autoverification was implemented in May 2020

Autoverification Criteria

The lab defined results **unsuitable** for autoverification as:

1) Test result below or above test analytical measuring range
   ↓Too low? < Acceptable! < ↑Too high?
2) Test result in the critical ranges ☠☠☠
3) Significantly different from previous patient history

Autoverified Tests

The 14 measured urine analytes that were reviewed are listed below:

Urea	**Sodium**	**Potassium**	**Chloride**	**Creatinine**
Bicarbonate	**Calcium**	**Phosphate**	**Magnesium**	**Total Protein**
Albumin	**Uric Acid**	**Triglceryide**	**Amylase**	

The 13 calculated results were into account violation of the acceptable criteria of the measured analytes. The list of calculated results are as shown below:

24hr Calcium	**24hr Phosphate**	**24hr Urea**	**24hr Sodium**	**24hr Potassium**
24hr Chloride	**24hr Creatinine**	**24hr Uric Acid**	**24hr Magnesium**	**24hr Albumin**
24hr Total Protein	**Albumin/Creatinine ratio**	**Protein/Creatinine ratio**		

Results

The lab had successfully implemented the settings and algorithms required to accurately hold back results that needed to be reviewed.

Accuracy of autoverification

From the audit performed using data from July to Sept 2020, all results were found to have been accurately autoverified or held back for review.

Autoverification rate

Number of urine results reported: **266,973**
Number of autoverified results: **217,239**
Autoverification rate : **81%** (equivalent time saved)

Time and cost savings

Manual review time (min) per result: 1
Time (hrs) saved for 217,239 results: 3620 (3 months)
Time (hrs) saved a year (estimated): **14,480**

Manpower cost saved/avoided: **6.6 FTE**
(assume 42hr work week per year)

Discussion and Conclusion

Prior to autoverification, the lab coped with the urine chemistry testing and result reporting process in the midst of its high workload by processing small batches throughout a prolonged 12 hour period:

1) The responsibility of reviewing results fell partly after office hours. This is not ideal as staff on evening and night shifts are working at skeletal strength and should be focusing on other more critical laboratory testing functions (e.g. attending to blood test requests from ED and ICUs).

2) Result review was delayed and not immediately after specimen analysis, resulting in some clinicians giving feedback regarding the delay in result reporting.

With an aging population and increasing prevalence of chronic diseases, laboratory medicine can expect a continuous increment in workload and lab investigations. Manual reviewing of results would become unsustainable and there would be a greater need to setup intelligent systems to automate result review processes.

Autoverification of urine chemistry results had demonstrated capacity to significantly improve operational efficiency through automation. This allows staff to focus attention on critical tests functions, quality assurance and research.

The lab will next aim to autoverify results from blood chemistry tests, starting with requests from primary healthcare (eg. polyclinics).